



# Assessing the efficacy of a specific physiotherapy intervention for the prevention of low back pain in female adolescent rowers: A field study

**Alison M Thorpe** BAppSc (Physio), Grad Dip Sports Physio, MPhil(Physio)<sup>1</sup>

**Peter B O'Sullivan** Grad Dip Manip Ther, PhD<sup>1</sup>

**Angus Burnett** BPE (Hons), PhD<sup>2</sup>

**Joao-Paulo Caneiro** BSc(Physio), M Sport Physio, MSc Human Movement<sup>1</sup>

<sup>1</sup> School of Physiotherapy, Curtin University of Technology  
GPO Box U1987, Perth  
WESTERN AUSTRALIA 6845

<sup>2</sup> School of Exercise, Biomedical and Health Sciences, Edith Cowan University  
270 Joondalup Drive, Joondalup  
WESTERN AUSTRALIA 6027

## Correspondence to:

Prof Peter B O'Sullivan  
School of Physiotherapy, Curtin University of Technology  
GPO Box U1987, Perth  
WESTERN AUSTRALIA 6845  
Email P.O'Sullivan@curtin.edu.au  
Phone +61 8 9266 3629  
Fax +61 8 9266 3699

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## ABSTRACT

**Objectives:** To determine the efficacy of a specific physiotherapy intervention administered to adolescent female rowers with the aim to decrease the prevalence of low back pain (LBP) and associated levels of pain and disability.

**Design:** A non randomized controlled field study in adolescent female rowers with and without LBP.

**Setting:** Curtin University of Technology, Western Australia and the participating private school boatshed, Perth, Western Australia.

**Participants:** Participants were 82 adolescent female rowers, with and without LBP. These participants attended the same school and were aged between 13 – 17 years [experimental group 13.9(0.9) years, control group 13.8(1.0) years]

**Outcome Measures:** Primary outcome measures in this study included; LBP point prevalence, pain intensity (utilizing a visual analogue scale) and disability level (utilizing a modified Oswestry questionnaire). These measures were taken at four time points over the rowing season.

**Results:** The experimental group demonstrated a significant reduction in the prevalence of LBP across the rowing season. [48% to 19% pre-season to mid-season and from 48% to 24% pre-season to end-season]. The

prevalence of LBP in the control group slightly increased [22% to 25% pre-season to mid-season and was unchanged at 22% pre-season to end-season]. A significant increase in the proportion of subjects pain-free was shown in the experimental group at mid-season compared with pre-season ( $p=0.007$ ), but no change thereafter ( $p>0.05$ ). In the control group the proportion pain-free remained relatively stable across the four time points ( $p>0.2$  for changes between consecutive times). The experimental group rowers demonstrated reduced pain intensity over the course of the rowing season ( $p<0.05$ ) compared to the control group [mean pre-end season exp 6.4(21.0), control -2.7(17.6)  $Z = -2.283$ ,  $p = 0.022$ ]. Levels of disability did not differ between the groups across the rowing season.

**Conclusions:** A specific physiotherapy exercise intervention was effective in reducing the prevalence of LBP in a population of adolescent female rowers and reducing pain intensity levels in subjects who complained of LBP at the commencement of the rowing season. A randomized trial to test the intervention under more rigorous scientific conditions is recommended.

**Key Words:** low back pain, rowers, exercise intervention, female, adolescent

## INTRODUCTION

Low back pain (LBP) in adolescence has been shown to be a significant risk factor for LBP in adulthood, with the strongest predictor of future LBP being a prior history of LBP (Hestbaek et al, 2006). High prevalence rates of LBP (24%) among children and adolescents have been demonstrated in several studies (Balague, 1999, 2003; Hestbaek et al, 2006); with the highest prevalence amongst girls than boys (Balague et al, 1999).

Participants in particular sports such as rowing have shown a greater disposition to reporting LBP (Burnett et al, 2008). A recent study of adolescent female rowers demonstrated a LBP point prevalence rate of 47.5% as compared to 15.5% in equally active non-rowers (Perich et al, 2006). These findings are supported by other research involving rowers of all ages and abilities (Howell, 1984; Perich et al, 2006; Stutchfield & Coleman, 2006).

Research has shown that *sports specific risk factors* associated with rowing, such as repeated lumbar flexion and loading often with the addition of spinal rotation and high levels of training times and volumes can potentially increase LBP prevalence (Adams & Dolan, 1995; Reid & McNair, 2000; McGregor et al, 2007). The lumbar spine may also be predisposed to strain as a result of *individual risk factors* of the rower, such as: habitual sitting postures (Perich et al, 2006), deficits in lumbo-pelvic motor control (McGregor et al, 2002; Caldwell et al, 2003), limitations in anterior pelvic tilt (Reid and McNair, 2000; Caldwell et al, 2003; McGregor et al, 2007), deficits in back muscle and lower limb endurance (Roy et al, 1990; Perich et al, 2009) and a

lack of flexibility in the hamstrings (Gajdosik, 1994; Reid and McNair, 2000) have all been reported in the literature as causative factors for LBP prevalence in rowers.

There are limited studies demonstrating the efficacy of *specific exercise interventions* for prevention of LBP in athletic populations. Generic programs with mixed outcomes have been reported such as: general core strengthening exercise programs in rugby players (Cusi et al, 2001) and in collegiate athletes (Nadler et al, 2002); trunk endurance exercises in college rowers (Tse et al, 2005); hamstring strengthening in female rowers Koutedakis et al (1997); muscle-specific exercises aiming at segmental control in young female gymnasts with and without LBP (Harringe et al, 2007). These studies had mixed outcomes and failed to demonstrate efficacy.

To date, only one study has tested an individually applied, specific physiotherapy exercise intervention as part of a multi-dimensional intervention in a rowing population. Perich et al (2008) demonstrated a significant lower prevalence of LBP in the intervention group (26%) as compared to the control group (46%). However, the education, physical conditioning, coaching or rowing/ergometer sessions were not controlled for, making it unclear as to the specific effect of the exercise intervention itself, in reducing LBP prevalence. Therefore, the aim of the current study was to determine the efficacy of the specific physiotherapy exercise intervention undertaken in the previous study (Perich et al 2008) within a field study, whilst controlling for the other components of the multi-dimensional intervention program.

## METHODS

### Ethical Approval

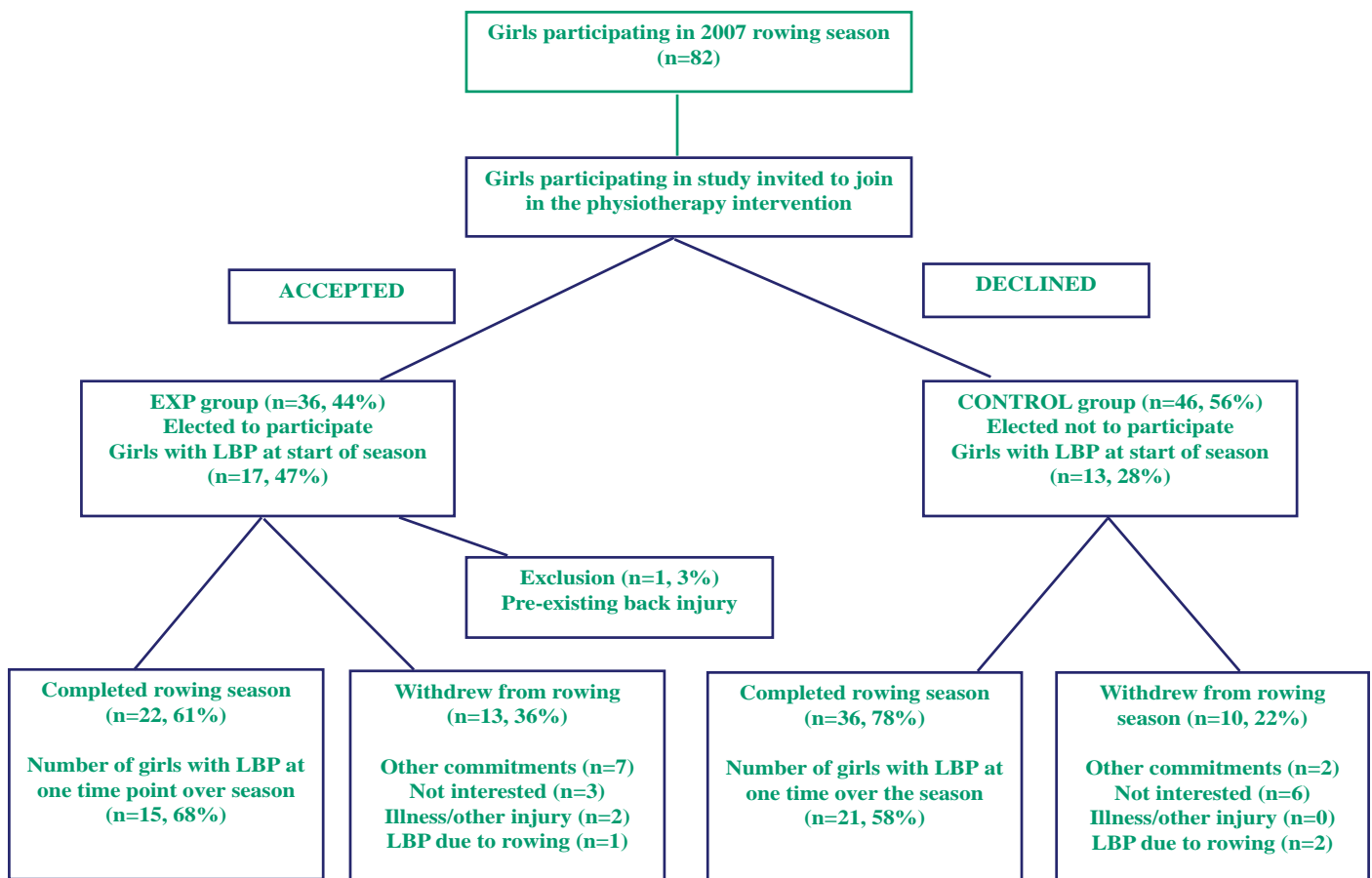
Ethical approval was granted by the Human Research Ethics Committee at Curtin University of Technology, Perth, Western Australia.

### Subjects

There were 82 girls with and without LBP, aged 13-17 years, from a private school in Perth, Western Australia participating in the Independent Girls Schools Sports Association 2007 rowing season.

A non-randomised controlled field study design was chosen as it best replicates real life clinical practice. All subjects ( $n=82$ ) were offered the opportunity to participate in the physiotherapy intervention, with the fees associated being standard physiotherapy consultation charges. Subjects who indicated a willingness to undergo the intervention ( $n=36$ ) were assigned to the experimental group while those who did not were assigned to the control group ( $n=46$ ). Subjects and their parents were provided with an information sheet outlining the purpose of the study and an informed consent was completed prior to participation in the study. Subjects were excluded from the study if they had pre-existing LBP due to previous spinal trauma unrelated to rowing, or diagnosed specific lumbar spine disorders such as spondylolisthesis, inflammatory disorders or neurologic conditions ( $n=1$ ). The subjects who withdrew from each group throughout the rowing season were requested to fill in a questionnaire outlining the reason for their withdrawal. These were excluded from further analysis (exp  $n=13$ , control  $n=10$ ).

**FIGURE 1: The flow of subjects through this non-randomised controlled trial outlining withdrawals, reasons for withdrawal and the proportion of subjects with LBP in each group.**



### Intervention

The format for the study was:

- i education session (experimental and control groups)
- ii physiotherapy exercise intervention program (experimental group)
- iii physical conditioning program (experimental and control groups)

### Education Session

The education session was conducted by the same experienced physiotherapist involved with the musculoskeletal screening in the previous study (Perich et al, 2008). The session was of 1 hour duration and all subjects from both groups, their parents, physical education staff and rowing coaches were requested to attend. This session covered concepts such as: basic spinal mechanics, injury risk in rowing, potential LBP mechanisms in rowing, spinal posture education (while sitting, rowing and lifting), attitudes and coping strategies with regards to the management of LBP. This included seeking prompt advice, informing parents

and coaches of the presence of LBP and the use of early symptomatic relief.

### Physiotherapy Intervention Program

Subjects in the experimental group were then required to undergo a musculoskeletal screening by an experienced physiotherapist. A team of 8 musculoskeletal and sports physiotherapists who were experienced in the assessment and exercise prescription protocol participated in the physiotherapy intervention. Initially, an *interview* was performed to assess current and previous history of LBP, pain location, aggravating and easing factors for LBP, as well as treatment history, attitudes towards LBP, current levels of rowing training and general activity. Subsequently, a musculoskeletal *physical examination* was performed examining spinal range of movement, directional pain provocation, habitual spinal postures in sitting and standing and spinal repositioning sense in sitting. Lumbo-pelvic motor control was assessed by the ability to maintain a

neutral lumbar spine with a relaxed thorax in sitting, whilst performing active hip flexion and knee extension, forward reach in sitting, sit to stand, half squat (with 90 degrees hip and knee position), squat with forward reach and the row position. Rowing technique and the ability to control end range lumbar flexion postures whilst rowing was assessed visually on the rowing ergometer.

An *individually prescribed exercise program* was instituted for subjects with and without LBP, based on the findings identified in the musculoskeletal screening. Each subject received a total of three physiotherapy sessions, with review at one and three weeks following the initial screening to ensure adherence and understanding of the exercise programs and to progress the exercises. There was no other physiotherapy treatment or manual therapy administered. Individual exercises which formed part of the physiotherapy intervention are illustrated in figure 2.

**FIGURE 2: Rowing exercises included in the physiotherapy intervention programme.**



Subjects in the experimental group received an exercise sheet with their individual physiotherapy intervention presented in picture form, with a brief explanation of the exercises. They were requested to undertake the exercises marked by the physiotherapist daily throughout the course of the season. The exercises and repetitions were assessed and progressed at each session to enhance both spinal motor control and lower limb and back muscle endurance. Subjects were asked to fill in a compliance sheet to indicate if the exercises were undertaken, however this data was not collected as there was poor adherence to completing the compliance sheet. In spite of this most girls indicated and demonstrated that they had complied with the program.

#### *Physical Conditioning Program*

The physical conditioning program used in this study was the same as that used in the previous study by Perich et al (2008) which was designed to increase lower limb and back muscle endurance, enhance general conditioning and improve postural awareness. The implementation of the

program was undertaken by the school's rowing coaches and physical education staff and remained a constant between groups in this study. Activities included in this program consisted of aerobic conditioning, hill running, strength and conditioning circuits and flexibility training. The principal researcher also attended two physical conditioning sessions after the completion of the physiotherapy reviews to reinforce compliance with the intervention program in the experimental group.

#### **Data Collection and Analysis**

##### *Anthropometric Measures*

Age, height and weight measures were collected to ensure similarities in the trial sample between both groups.

##### *LBP Prevalence and Aggravating Factors*

LBP prevalence was determined by asking the question at baseline pre-season "Have you experienced low back pain?" and at mid-season (week 11), end-season (week 23) and post-season (week 33) asking the question "Have you experienced back

pain since the commencement of the rowing season?" A questionnaire was completed examining factors that 'bring on' or 'exacerbate pain' in relation to rowing, ergometer training and lifting the boats.

##### *LBP Location*

Subjects were requested to fill in a body chart illustrating the area they currently experienced back pain.

##### *LBP Intensity*

Subjects were asked to rate their pain on a 10cm visual analogue scale (VAS) with the start point on the left side of the horizontal line being "no pain" and the end point on the right side of the line being the "worst pain imaginable". A percentage score was recorded. This method of measuring pain intensity is both reliable and valid (Jensen et al, 1989; Ogon et al, 1996).

##### *LBP Disability*

Subjects were asked to complete the modified Oswestry questionnaire which

is a reliable and valid measure of function consisting of nine sections: pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life and traveling. (Fairbank & Davies, 1980). Subjects select the statement in each section which is most appropriate to their level of disability and a percentage score was recorded. The section relating to sex life was deleted for this study, however the test still retains its validity (Page et al, 2002).

These questionnaires, body chart and visual analogue scale were collected at the beginning of the rowing season (week 1), mid season (week 11), end of season (week 23) and 10 weeks post season (week 33)

### Statistical Analysis

An independent t-test was performed on the baseline data, to assess for group differences with regard to anthropometric data of height, weight and age at entry to the trial.

To assess for group differences with regard to VAS and Oswestry scores at

entry to the trial an independent t-test was performed on the baseline data of subjects with LBP in each group.

Point prevalence was compared at four occasions over the rowing season between the control and experimental groups. Prevalence of LBP was defined as pain intensity of a VAS score greater than 1, in order to eliminate low levels of discomfort associated with rowing and muscle fatigue. Logistic regression was used to model the proportions pain-free over the 4-time points for both groups. Within-subject correlation over the times was taken into account for calculation of standard errors and assessment of parameter estimates using a Wald Chi-square test statistic.

A Mann Whitney-U non parametric test was used to assess differences in change scores of pain intensity and disability levels between the two groups, in subjects with LBP, across the time frame (the difference between the baseline pre-season score and the mid-season, end-season and post-season score for each individual) of each measure, to assess

differences between the two groups after the intervention period. This test was performed to account for the large number of zero scores for subjects without back pain, resulting in a zero inflation effect.

The level for statistical significance was set at the 95% confidence limit. Statistical analysis was performed using Microsoft Excel and SPSS software version 15.

## RESULTS

### Baseline Data

There was no significant difference in baseline data illustrated in table 1 with regards to the anthropometric data between groups. Pre-existing LBP prevalence (VAS score greater than 1 out of 10) was recorded at baseline pre-season. Statistical analysis demonstrated no significant difference in baseline levels of pain intensity and disability in subjects with LBP, between groups. Differences in prevalence at baseline were found to be statistically significant and will be discussed further below.

**TABLE 1: Baseline measures of anthropometric data, prevalence, pain intensity and disability of all subjects involved in the 2007 school rowing program.**

	EXPERIMENTAL (n=36)Mean (SD)	CONTROL (n=46)Mean (SD)
Age	13.9(0.9)	13.8(1.0)
Height	167.4(10.6)	168.1(8.2)
Weight	58.9(8.0)	58.4(9.04)
Prevalence VAS > 1	48%	22%
Pain IntensityMean VAS (mm)	32.5(14.5)(n=10)	25.4(7.7)(n=8)
DisabilityMean Oswestry %	5.3(4.6)(n=10)	5.4(4.3)(n=8)

*Pain intensity (mean VAS) and disability (mean oswestry) refer to those subjects at baseline who currently experienced LBP.*

**TABLE 2: Baseline measures of anthropometric dataa, proportion of withdrawals, pain intensity and disability of subjects who withdrew from the 2007 school rowing program.**

	EXP (n=12)Mean (SD)	CONTROL (n=10)Mean (SD)
Age	14.2(1.4)	13.5(0.5)
Height	166.2(6.6)	165.0(6.0)
Weight	55.5(8.4)	51.3(7.4)
Proportion of subjects who withdrew	33%	22%
Pain IntensityMean VAS (mm)	46.1(22.4)	13.9(5.6)
DisabilityMean Oswestry (out of 100)	5.6(7.0)	4.0(0)

### Withdrawals

Withdrawals in each group were requested to fill in a questionnaire outlining the reason for their withdrawal from the school rowing program (which is cited in figure 1) and were excluded from further analysis in this study. One subject in the experimental group was excluded from the study due to sustaining a traumatic lifting injury to the low back (independent of rowing) prior to the commencement of the 2007 rowing season.

### Aggravating Factors and Location of Pain

The self-reported factors related to rowing that caused the initial onset or exacerbated LBP: lifting the boat (exp n=6, control n=3), sweep rowing (exp n=8, control n=4), rowing in quadruple or single scull (exp n=7, control n=1), ergometer rowing (exp n=11, control n=4), long rowing sessions (exp n=6, control n=4) or other issues related to sustained postures or

weight training (exp n=4). The location of pain was identified as lumbar (exp n=13), thoracic (exp n=4), buttock (exp n=1). Six subjects also reported shoulder pain.

### LBP Prevalence

The experimental group demonstrated a significant reduction in the prevalence of LBP across the rowing season (Fig.2) from 48% to 19% pre-season to mid-season and from 48% to 24% pre-season to end-season while in the control group the prevalence of LBP slightly increased from 22% to 25% pre-season to mid-season and was unchanged at 22% pre-season to end-season. This was in spite of a significantly greater number of subjects in the experimental group having pre-existing LBP.

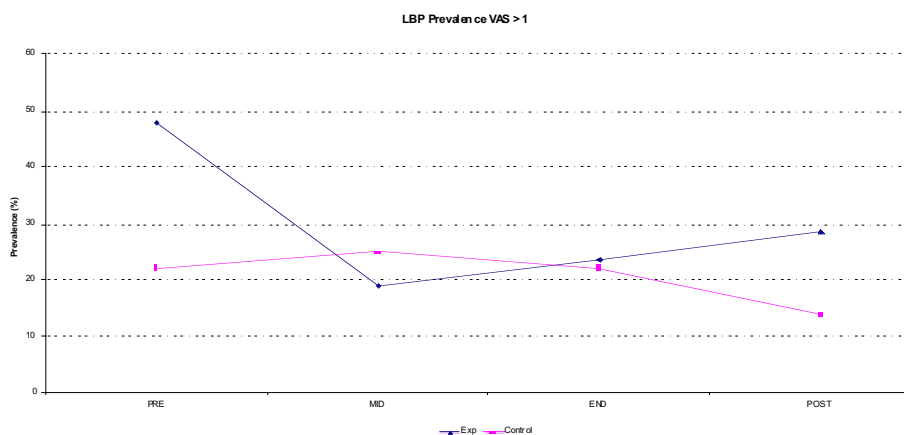
A between-group comparison of the proportions pain-free for each of the 4 time points found the two groups differed

significantly only at baseline pre-season ( $p=0.05$ ). Modeling within-group changes across the times revealed there was a significant increase in the proportion pain-free in the experimental group at mid-season as compared to pre-season ( $p=0.007$ ) but no change thereafter ( $p>0.05$ ), indicating a significant reduction of LBP prevalence in the experimental group after the intervention. Within the control group the proportion pain-free remained relatively stable across the 4 times ( $p>0.2$ ) for changes between consecutive times.

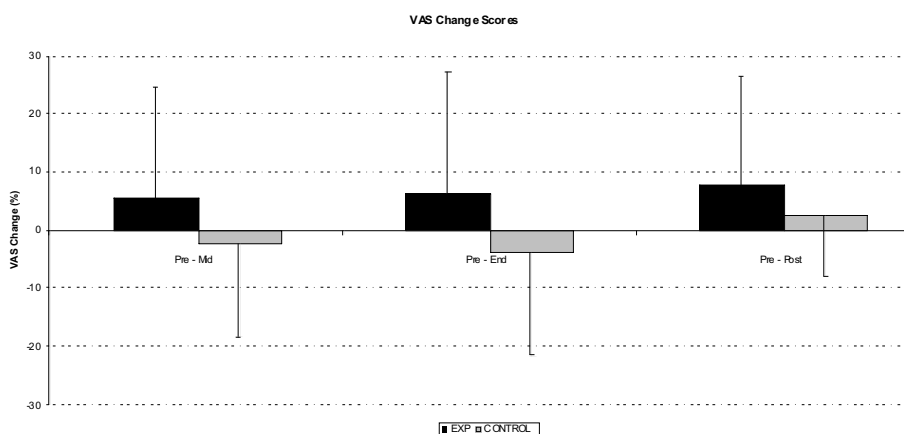
### Changes in Pain Intensity and Disability

Differences in change scores (the difference between the baseline pre-season score and the mid-season, end-season or post-season score) of pain intensity and disability levels between groups across the time frame are illustrated in figures 4 and 5. Six subjects

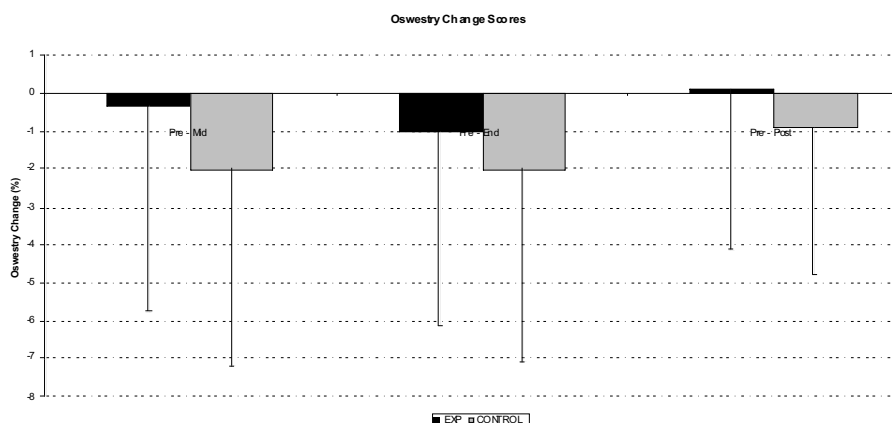
**FIGURE 3: LBP Point Prevalence VAS>1 (n=58). Point prevalence values were recorded for subjects in both groups who completed the rowing season.**



**FIGURE 4: Pain intensity change scores for subjects with LBP in each group. The change in VAS score is defined as a positive score for a reduction in pain intensity and defined as a negative score for an increase in pain intensity.**



**FIGURE 5: Disability level change scores (Oswestry) for subjects with LBP in each group. The change in Oswestry score is defined as a positive score for a reduction in disability level and defined as a negative score for an increase in disability level.**



in the experimental group and 10 subjects in the control group reported no pain at any stage during the rowing season.

Changes in VAS score across the rowing season was defined as a positive score for a reduction in VAS (decrease in levels of pain) and defined as a negative score for an increase in VAS. There was a significant difference in pain intensity VAS change scores between groups, when comparing end-season score with baseline pre-season score [mean pre-end season exp 6.4(21.0), control -2.7(17.6)  $Z = -2.283$ ,  $p = 0.022$ ]. This illustrates a significant reduction in pain intensity over the course of the rowing season for the experimental group who received the physiotherapy intervention..

Changes in Oswestry scores across the rowing season were defined as a positive score indicating reduced levels of disability and defined as a negative score indicating an increase in levels of disability. Statistical analysis of changes in the level of disability (Oswestry) mid-season, end-season and post-season when compared to baseline pre-season did not illustrate significant differences between groups. However, the trend illustrated by the graph in figure 4 suggests a trend for slightly greater levels of disability in the control group across the rowing season as compared to the experimental group.

## DISCUSSION

The current study tested the efficacy of the specific physiotherapy intervention in isolation that was a component of the multi-dimensional study previously

undertaken in the study by Perich et al (2008). Although it is acknowledged that there are inherent limitations with a 'field study' design, the advantage of this methodology is that it closely reflects 'real life' clinical practice.

## LBP Prevalence

The specific physiotherapy intervention resulted in a reduction in the prevalence of LBP across the rowing season in the experimental group as compared to the control group. This change revealed a 29% reduction in LBP prevalence in the experimental group with a 3% increase in the control group across the rowing season. It is acknowledged that the self-selection bias for the physiotherapy intervention may have had the potential to provide a greater chance for the experimental group with a higher pain prevalence and an expectation for treatment to improve their status. In spite of this, whilst controlling for the education session, physical conditioning programs and coaching components of the intervention the findings support that the physiotherapy intervention had a significant impact on the prevalence of LBP in this population. This is in line with previous research by Perich et al (2009), which demonstrated a reduction in prevalence of up to 12% across the rowing season in the experimental group following the multi-dimensional intervention.

In addition to the change in prevalence there was also a reduction in pain intensity in the experimental group although differences were small. In contrast the baseline level of disability was low and

remained low and unchanged throughout the rowing season suggesting that the LBP experienced had little impact on activities of daily living as measured by the modified Oswestry questionnaire. This finding may reflect a lack sensitivity of the questionnaire to disability related to rowing in an adolescent population. It is reported that the Oswestry questionnaire is more sensitive to moderate rather than low levels of disability (Roland & Fairbank, 2000). Conversely it may be that these subjects coped well with their LBP.

## Exercise Interventions

Overall knowledge of the impact of specific physiotherapy exercise interventions on the effect on LBP in sporting populations is very limited. As part of clinical physiotherapy practice, exercise prescription by physiotherapists formulates a significant portion of the treatment and management of athletes. The lack of evidence base reported in the literature questions the validity of the many physiotherapy exercise interventions which are prescribed on a daily basis.

Many sporting groups undertake 'trunk strengthening' or 'core stability training' in an attempt to reduce pain prevalence, intensity and disability associated with LBP, however no significant benefits from these interventions have been demonstrated (Nadler et al, 2000; Cusi et al, 2001). Specific muscle control exercises delivered in a group setting as part of weekly training regime were of benefit in reducing pain intensity and functional disability in adolescent

gymnasts, however the authors acknowledge a number of methodological limitations in the research design (Harringe et al, 2007).

The findings of the current study adds to the evidence base for specific physiotherapy exercise interventions in sporting groups and is consistent with the previous study in adolescent female rowers (Perich et al, 2009).

### Limitations

The present study has a number of methodological limitations which need to be acknowledged. This non-randomised controlled study was conducted as a field based study where the subjects elected to participate in the physiotherapy intervention. The uneven group size was the result of more subjects with LBP self selecting for the physiotherapy intervention, causing a self-selection bias. This may have the potential to provide more chance for the experimental group with a higher pain prevalence to improve pain prevalence itself. Despite this, the significant reduction in LBP prevalence and pain intensity levels at the end of season in the experimental group suggesting that the physiotherapy intervention was effective.

Low numbers in each group who completed the rowing season were due to a high number of withdrawals from each group, with the baseline pain intensity level in the subjects who withdrew, higher in the experimental group. In spite of this, it is interesting to note that LBP was cited as a reason for withdrawing from the rowing program in only 3 subjects (exp group n=1, control group n=2).

The lack of randomization and blinding in this study is also considered to be a limitation. Although it was possible that some of the exercises in the intervention may have been shown to the control group subjects, the fact that the physiotherapy intervention was based on individual screening and an individually prescribed exercise program, it is unlikely subjects in the control group had the understanding and knowledge to adequately perform the physiotherapy intervention as a result of observing subjects in the experimental group do their exercises.

Statistical analysis involved multiple testing of point prevalence, pain intensity and disability level increasing the chance of error. A confidence interval was set at 95%, which was based on the point prevalence findings in the previous study by Perich et al (2008), with the potential for a significant result occurring by chance with p-value set at 0.05.

As standard physiotherapy consultation fees were charged to the subjects receiving the physiotherapy intervention, the potential self selection bias could be based on an economic decision by the family of the subject.

Because of the study design limitations, the strength of these findings is reduced. Questions such as the input and level of support from the physical education and coaching staff within the school and level of compliance amongst subjects in the experimental group have not been answered.

### Recommendations

Future studies with a randomized controlled design and long term follow-up using a patient functional specific questionnaire as a measure of disability would assist in evaluating the true effectiveness of this physiotherapy exercise intervention. However the results of the study reflect the real life situation of clinical practice and exercise prescription in a sporting environment.

### CONCLUSIONS

The finding of this field study support that a specific individually prescribed physiotherapy exercise intervention was associated with a reduction in the prevalence of LBP in a population of adolescent female rowers across a rowing season. Reduced levels of LBP intensity in subjects who received the physiotherapy intervention was also observed although there were no statistically significant changes in disability levels across the rowing season. These findings need to be supported by randomized controlled study before their validity can be assured.

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